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TWO SIDES OF THE 7.1 KA BP RCC EVENT IN THE SOUTHERN CARPATHIAN BASIN: HUMAN ADAPTATION TO THE CHANGES IN ENVIRONMENTAL CONDITIONS DURING THE MIDDLE AND LATE NEOLITHIC

One of the rapid climate change (RCC) events, which had lesser impact on the environmental conditions of the Northern Hemisphere but had stronger impact on the micro regional scale, is 7.1 ka BP event. Cooler and wetter conditions at its onset seem to have accompanied initial dispersal of the central European LBK from its core area to the regions, among other, of western Transdanubia and beyond, populating the area south of the Drava River. In the local chronology, this change in the material culture is marked by the appearance of the Middle Neolithic around 5400 BC. The end of this climate event is, however, marked by initial stage of dry and warmer conditions around 5000 BC which enabled settlement formation in the lowlands of the Eastern Slavonia. After this initial phase and the formation of the Late Neolithic tell settlements, over a period of about 500 years change in humidity and temperature occurred, eventually leading to the abandonment of most of the tell sites. Human adaptation to the changes in environmental conditions in both micro regions and archaeological contexts is discussed in this paper.

Key words: RCC 7.1 ka BP; LBK; Middle and Late Neolithic; tells / *Ključne riječi: RCC 7.1 ka BP; LTK; srednji i kasni neolitik; tel naselja*

Introduction

In Croatian archaeology, co-dependence between past societies and their immediate environment is traditionally ignored with some recent exceptions (Botić 2016a; 2016b; 2017a). Attempts of reconstructing past climate and weather patterns are more common in the field of history, based on the written records rather than on the available environmental datasets (e.g. Kužić 2014; Petrić 2014; Blöschl *et al.* 2020; Botić 2020a, etc.). Nor are there any substantial palaeoenvironmental datasets and their studies available.[1]

In this paper, an attempt will be made to link certain changes in the remains of material culture from archaeological records observed during the Middle and the beginning of

1 Only two palinological studies are available for the northern Croatia: for the Neolithic period in the Eastern Slavonia see Bakrač *et al.* 2015 and for the last 2000 years in the area south of Karlovac, i.e. central Croatia see Hruševar *et al.* 2020. Studies providing some additional environmental datasets for the continental part of Croatia, such as stable isotope records from speleothems in Nova Grgosova cave near Samobor (Surić *et al.* 2020; 2021) do not provide any link between past societies and environment/climate changes in that region.

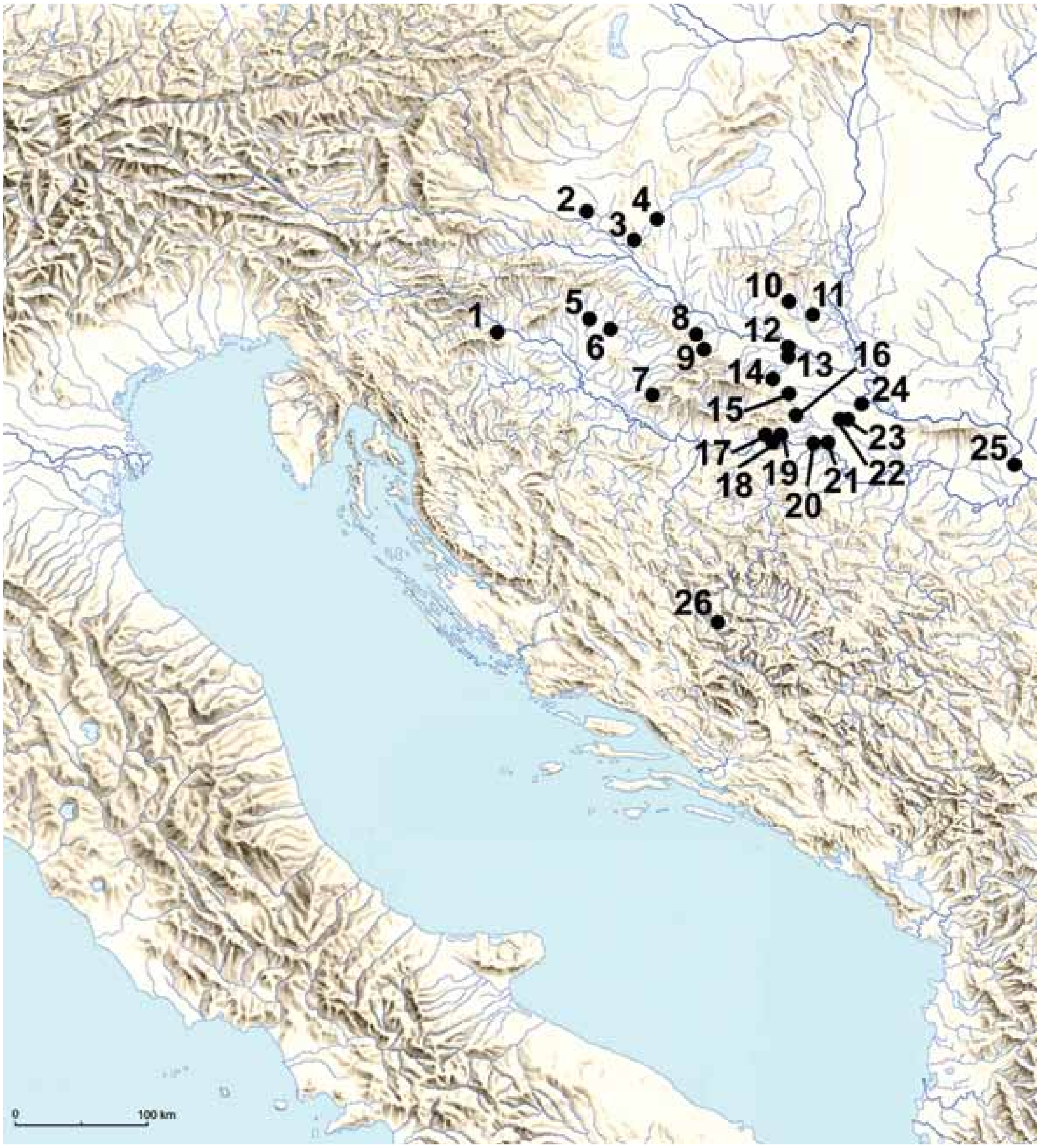

Fig. 1. Map of the sites mentioned in the text (made by K. Botić; map source: Institute of Archaeology, Zagreb): / *Sl. 1. Karta lokaliteta spomenutih u tekstu (izradila K. Botić; izvor: Institut za arheologiju, Zagreb)*:

1 Nova Grgosova cave
2 Szentgyörgyvölgy-Pityerdomb
3 Sormás-Török-földek
4 Zalavar
5 Gornji Brezovljani
6 Malo Korenovo
7 Kukunjevac – Brod
8 Virovitica – Brekinja
9 Pepelana
10 Szemely-Irtás
11 Szederkény-Kukorica-dűlő
12 Donji Miholjac – Vrancari
13 Golinci – Selište
14 Velimirovac – Arenda 1
15 Podgorač – Ražište
16 Novi Perkovci – Krčavina
17 Slavonski Brod – Galovo
18 Gornja Vrba – Savsko polje
19 Zadubravlje – Dužine
20 Kruševica – Njivice
21 Dubovo – Košno
22 Vinkovci – Zablaće
23 Vinkovci – Sopot
24 Bršadin – Pašnjak pod selom
25 Vinča Belo Brdo
26 Prokoško jezero

the Late Neolithic period[2] in the continental part of Croatia, i.e. Sava–Drava–Danube interfluve with global or regional climate/environmental data. Earlier attempts to this approach (Botić 2016a; 2016b; 2017a) showed striking coincidence between appearance and development of Neolithic agriculturally based societies (see Gronenborn 2010: 67 with bibliography) and their transformation at the onset of Eneolithic with the major global climate events. There are indications that the same might be true for the Middle and the beginning of the Late Neolithic. Although local palaeoenvironmental data is largely missing, certain aspects of archaeological record may corroborate this assumption.

Theoretical approach to the dynamic social changes which occurred during the process of Neolithisation is not, however, in the descriptive scope of this paper. The adaptive cycles and resilience approach, helpful in understanding quite complex interconnections between social dynamics and climate/environment (Gronenborn 2012; 2014; Gronenborn *et al*. 2020 – all with the extensive bibliography) demand more structured archaeological and environmental datasets which are still not fully available. Therefore, simpler quantitative approach, when possible, is used.

RCC and IRD definitions

Rapid Climate Change (RCC) events, the Holocene cold anomalies, were defined as repetitive global cooling anomalies which roughly appear every 1450 years (Mayewski *et al.* 1997; 2004; Weninger *et al.* 2009: 8). Six RCC periods were identified for the Holocene by Mayewski *et al.* (2004): 9000–8000, 6000–5000, 4200–3800, 3500–2500, 1200–1000, and 600–150 calBP.[3] Weaker solar activity (Perry, Hsu 2000; Bond *et al.* 2001; Mayewski *et al.* 2004: 244; Marino *et al.* 2009: 3246; Wirth *et al.* 2013, Fig. 9) but mostly interchange of High (Siberian and the Azores) and Low (Iceland) atmospheric pressure gradients creating conditions that support an influx of extremely cold air from the polar regions into Europe (Weninger *et al.* 2014; Weninger, Harper 2015: 478, Fig. 2; Bento *et al.* 2015: 5) are characteristic for these events. The onset of such events consists of North Atlantic (Iceland) Low spreading in two directions – over the British isles to Scandinavia and south-east over the Iberian peninsula throughout the Mediterranean to the Middle East, while Siberian High is limited to the north-east and east Europe (Weninger, Harper 2015: 478, Fig. 2 up). During the RCC event North Atlantic Low is spreading only in the north-east direction while the cold air of pronounced Siberian High is spreading in two directions: over the east and south-east Europe to the Middle East (across the Mediterranean) and over the most of the southern Asia (Weninger, Harper 2015: 478, Fig. 2 down).

Ice rafted debris (IRD)[4] events, on the other hand, were described as the cooling events triggered by the changes in salinity of the North Atlantic caused by melting phases of the Laurentide Ice Sheet and iceberg discharges that caused fresh-water and sediment outbursts (Alley, Agustsdottir 2005; Budja 2007; Gronenborn 2009: 97 etc.). Change in salinity influenced North Atlantic thermohaline circulation (Bond *et al.* 2001) and thus

2 In local chronology, the period considered Middle Neolithic lasts between 5400 and roughly 5000 BC which marks the beginning of the Late Neolithic (Botić 2017a; 2019; 2020b; 2020c).

3 BP = before present, i.e. before 1950. The last RCC period corresponds to the Little Ice Age (LIA).

4 Or ice rafted detritus. They are also known as Bond events, with Bond 0 corresponding to the Little Ice Age, Bond 3 slightly predating the Early Bronze Age in the local chronology and Bond 5a corresponding to the 8.2 ka BP event (Bond *et al*. 1997; 2001; Gronenborn 2009). For the specific hydrological conditions during this last cold event see Magny *et al*. 2003.

the weather patterns. IRD phases are well correlated with insolation cycles and may be triggered by them (Bond *et al.* 2001). Wirth *et al.* (2013: Fig. 9) established two scenarios for high and low solar activity in correlation with the atmospheric circulation:

1) during the high solar activity North Atlantic Oscillation (NAO) shows positive phase; strong Azores High and strong Iceland Low maintain conditions in Europe in which northern parts receive more pronounced precipitation while in southern Europe precipitation is reduced and temperature more pronounced; windiness is also reduced;

2) during the low solar activity NAO shows negative phase; pronounced Siberian High but very weak Azores High and Island Low maintain different conditions in Europe – precipitation is more pronounced in the southern parts with less pronounced temperatures while in the north of the continent pronounced temperature and precipitation prevail; windiness is pronounced.

It should be noted here that volcanic activity may influence the solar intensity during shorter or longer periods as well. Past volcanic eruptions with their confirmed explosivity indexes are listed in **Tab. 1**. Certain bias is visible in the youngest listed time span regarding the total number of confirmed VEI, as the remains of younger eruptions are probably better preserved, although all the older listed time spans show relative constant. In the time span 5999–5000 BC, under discussion in this paper, lower number of VEI 5 eruptions seems to have occurred than in the previous and later time spans (6999–6000 BC, 4999–4000 BC). It is, however, important to note that in the period between 6999 and 6000 BC a total of 104 eruptions was documented between 6400 and 6000 BC. The strongest VEI 7 eruption occurred in 5677±150 BC (Crater Lake[5] volcano, Oregon, USA),[6] followed by two VEI 6 eruptions in 5550±75 BC (Tao-Rusyr Caldera, Kuril Islands, situated between Japan and the Russian Kamchatka Peninsula in the Pacific) and 5550±100 BC (Mashu, Hokkaido, Japan).[7] Intensity of emission of volcanic sulphate (SO_2) is shown on **Fig. 2**; two strong emissions coincide with the IRD 5b / 7.1 ka RCC event.

Time span	Total docu-mented eruptions	VEI 0	VEI 1	VEI 2	VEI 3	VEI 4	VEI 5	VEI 6	VEI 7	Total con-firmed VEI	Total con-firmed VEI %
2999–2000 BC	294	27	2	15	32	31	20	1	1	129	43.878
3999–3000 BC	230	23	3	12	12	20	11	3	0	84	36.522
4999–4000 BC	259	28	2	22	19	11	11	4	1	98	37.838
5999–5000 BC	227	22	1	17	22	11	8	4	1	86	37.885
6999–6000 BC	198	13	0	8	17	18	11	3	1	71	35.859

Table 1. Number of documented past volcanic eruptions and eruptions with confirmed Volcanic Explosivity Index (VEI) (data source: Global Volcanism Program, http://www.volcano.si.edu) / *Tablica 1. Broj dokumentiranih vulkanskih erupcija i erupcija s potvrđenim indeksom vulkanske eksplozivnosti (VEI) u prošlosti (izvor podataka: Global Volcanism Program, http://www.volcano.si.edu)*

5 Collapse of Mt. Mazama created Crater Lake, possibly during this eruption. Effects of this event may have worsened weather patterns in Europe for about five years, threatening still fragile subsistence systems (e.g. Strien, Gronenborn 2005).

6 Somewhat earlier, in 5700±16 BC, VEI 6 eruption of Khangar volcano occurred on the Russian Kamchatka Peninsula in the Pacific.

7 For comparison, current eruption of Cumbre Vieja volcano on the Canary Island La Palma is classified as VEI 2 (source: Global Disaster Alert and Coordination Sytem).

7.1 ka BP event and the archaeological data (Fig. 2)

Global and macro regional environmental data[8]

Some recent studies about interconnection of environmental and archaeological data focused on RCC or IRD events, both with compelling results. Gronenborn (e.g. Gronenborn 2007; 2010; 2012; Gronenborn *et al.* 2014) links the IRD 5b phase to the time span 5700–5100 BC and to the period of the beginning of the LBK in Central Europe, starting about 5500 BC (Gronenborn 2012: Abb. 3). Period of the drop in the ^{14}C production and reduced tree-ring width immediately predates the start of the LBK and in the northern Alpine region pronounced flooding activity is recorded (Gronenborn 2012: Abb. 3; Wirth *et al.* 2013: Fig. 6).[9] In the global palaeoclimate proxies this period is marked by drop in temperature, slightly pronounced Siberian High and deeper Iceland Low, drop in north-east Atlantic overflow/silt size, much colder North Atlantic summer sea surface temperature (SST) etc. (Indermühle *et al.* 1999; Mayewski *et al.* 2004: 245–257, Fig. 2). At the same time, Dead Sea level is low indicating a dry phase in the Middle East (Migowski *et al.* 2006; Gronenborn 2009: 98, Fig. 1). In the southern Alpine region, however, low flood activity is recorded (Wirth *et al.* 2013: Fig. 6) as well as for the central and eastern European Plain while in the Mediterranean regions records show flood activities (Benito *et al.* 2015: Fig. 2). In the Northern Africa retreating of monsoonal rains is recorded in the period before 5300 BC at which point desiccation of the Egyptian Sahara started (Kuper, Kröpelin 2006). Short return of the humid conditions in the eastern Sahara region is recorded around 4700 BC followed by strong and rapid desiccation period in which significant depopulation is recorded by the 4000 BC (Reimer *et al.* 2013: Fig. 2).

On the other hand, Weninger *et al.* (2009; 2014 etc.) do not recognize stronger RCC event during the time span of the IRD 5b, focusing mainly on 8.2 ka and 6.0 ka BP events. In this paper we opt to observe changes in the environmental data around 5500–5100 BC as an RCC event[10] although it is better explained in the frame of IRD 5b event (*sensu* Gronenborn Gronenborn 2007; 2010; 2012 etc.). Interestingly, the climate proxies show somewhat different conditions in Europe during the 7.1 cal BP event from the previous 8.2 ka BP event, especially regarding hydrological conditions.

For the central and southern Carpathian Basin several studies including environmental data were published, of which two can be mentioned here: paper regarding the appearance of the Early Neolithic settlements at the onset of IRD 5a in the period of intensified flooding (Gulyás *et al.* 2020) and the paper about environmental conditions around tell sites at the end of the IRD 5b, i.e. period from slightly before 5000 BC to the mid-5th millennium BC (Gulyás, Sümegi 2011).

8 Environmental data is dated using BP years (see note 3), making it difficult for archaeologists to follow because archaeological contexts are dated in BC years. Several papers cited here have taken a step forward in addressing this problem: Gronenborn (2009; 2010; 2012 etc.) uses only BC dates for environmental data, while Weninger uses both BP and BC dates in his recent work (Weninger *et al.* 2014; Weninger, Harper 2015 etc.). We are providing parallel dates in Fig. 2.

9 Deposition frequency of subfossil oaks in the River Main Valley accelerated slightly before 5000 BC and the same happened in the northern Germany bogs (Leuschner *et al.* 2002; Spurk *et al.* 2002).

10 Palaeoclimate proxies show the same two phases of the event, the onset and the event itself. Further elaboration of this subject is out of the scope of this paper.

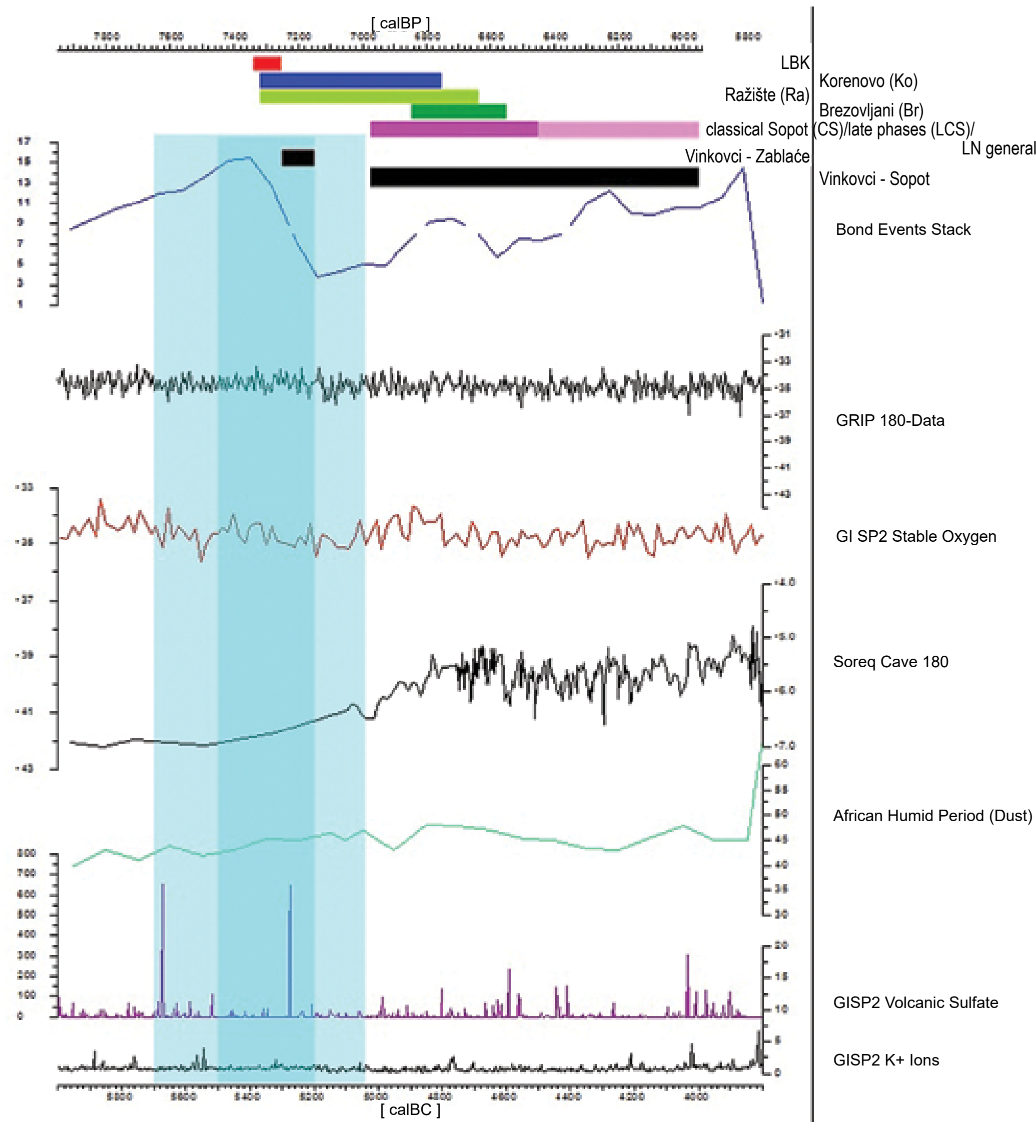

Fig. 2. Selected paleoclimatic proxies with the IRD 5b climatic event marked in pale blue: Bond events (Bond *et al.* 2001), Greenland GRIP and GISP2 ice-cores δ^{18}O as proxy for temperature (Grootes *et al.* 1993), Soreq Cave δ^{18}O as proxy for temperature in the Middle East (Bar-Matthews, Ayalon 2011), African Humid Period (Dust) as proxy for aridity (DeMenocal *et al.* 2000), GISP2 Volcanic SO_2 as proxy for reduced solar activity (Zielinski *et al.* 1994; 1997), high-resolution GISP2 nss (non-sea salt) [K+] as proxy for the Siberian High (Mayewski *et al.* 1997; Meeker, Mayewski 2002). The duration of pottery styles in the Sava–Drava–Danube interfluve is marked at the top, according to available radiocarbon dates. Climate data modelled in CalPal v.2021.8 program / *Sl. 2. Odabrani paleoklimatski podaci, klimatski događaj IRD 5b označen svjetloplavom bojom: Bond događaji (Bond* et al. *2001),* δ^{18}*O Grenlandske jezgre leda GRIP i GISP2 kao pokazatelji promjene temperature (Grootes* et al. *1993),* δ^{18}*O pećine Soreq kao pokazatelj promjene temperature na Bliskom istoku (Bar-Matthews, Ayalon 2011), Afričko vlažno razdoblje (fine čestice) kao pokazatelj isušivanja (DeMenocal* et al. *2000), GISP2 vulkanski* SO_2 *kao pokazatelj smanjene sunčeve aktivnosti (Zielinski* et al. *1994; 1997), GISP2 nss (non-sea salt = nemorska sol) [K+] kao pokazatelj za jačinu Sibirske anticiklone (Mayewski* et al. *1997; Meeker, Mayewski 2002). Trajanje keramičkih stilova u međurječju Sava–Drava–Dunav, prema dostupnim radiokarbonskim datumima, označeno je na vrhu. Klimatski podaci modelirani su u CalPal v.2021.8 programu*

Micro regional environmental data

Environmental datasets for the Sava–Drava–Danube interfluve are very sparse as stated before. In the wider region several datasets were published, although their diversity prevents more detailed comparison. Palinological record was published for Prokoško jezero (lake) in central Bosnia (Dörfler 2013) but this lake is situated at 1670 m a.s.l. while the documented sites in the interfluve lie between 80/90 and 250/260 m a.s.l. (Botić 2017a: 102, Tab. 2). Anthracological and palynological study of samples originating from the Sormás-Török-földek[11] Late Neolithic site and data provided by the geological core near Zalavar, both in Zala County in Southwestern Hungary (Náfrádi *et al.* 2015), present results which could probably be used as comparison in the reconstruction of the environment in the Drava River valley after 5000 BC but archaeological records for that period in the upper Drava River valley are currently not know. Speleothem data ($\delta^{18}O$ and $\delta^{13}C$ stable isotopes) from Nova Grgosova cave near Samobor in the westernmost part of the northern Croatia show pronounced peak of drier and colder conditions with abrupt change to wetter and warmer conditions after 5400 BC which continued for a long time (Surić *et al*. 2021: Figs 5–6). However, if the current weather pattern is observed, this area in the pre-Alpine region receives 1000–1100 mm of precipitation while the eastern part of the interfluve receives only about 600–700 mm or less (Zaninović 2008: 52), so the differences in hydrological conditions between these two micro regions should be taken into consideration for the past periods as well.[12] The only preliminary palynological report published for eastern Slavonia, i.e. eastern interfluve, and sampled at Sopot tell site shows two initial phases of settlement dated to the 6060–5890 BC (SOP-1) and to the 5050–4550 BC (SOP-2), including a temporal hiatus between the first occupation of the site by the Early Neolithic Starčevo population and the start of the second occupation at the beginning of the Late Neolithic by the Sopot population (Bakrač *et al.* 2015). Besides strong anthropogenic influence on the vegetation around the site in various phases of occupation, no precise data about other environmental changes can be found in this paper.

Archaeological record and indirect environmental data

The change in archaeological record[13] of the interfluve appears around 5400 BC, firstly in the Drava River valley (Botić 2019; 2017a; 2020b; Sekelj Ivančan, Balen 2006a; 2006b;

11 Difference in local chronological periodisation can be seen on the example of this paper: while in the Sava–Drava–Danube interfluve Sopot culture is perceived as the Late Neolithic occurrence, here it is treated as the Middle Neolithic one, mostly parallel with later Lengyel culture and only slightly younger than the latest LBK phase. Our opinion is that the older pottery style in this region is not Sopot *per se* but probably Brezovljani style, especially as it is perceived as an "import" from the region south of the Drava River. Brezovljani style appeared in the western part of the interfluve, in the region previously occupied by the Korenovo style, and spread east and northwards.

12 Mean annual temperature is about 10–11°C in most of the interfluve, reaching 12–13°C in the easternmost parts (Zaninović 2008: 34) which is similar to the conditions in the northern or central Balkans (see Ethier *et al.* 2017: Fig. 4). Connection with the Balkans and the Carpathian Basin is further confirmed by the presence of *Sus* sp. (pigs, less than 10%), caprines (sheep/goat, above 50%) and cattle (about 25%) in the Sava river valley at the Early Neolithic sites Slavonski Brod – Galovo and Zadubravlje – Dužine (Ethier *et al.* 2017: Fig. 3; Botić 2018: 56) which slightly predate the Early Neolithic sites in the Carpathian Basin.

13 Traditionally, in local chronology Early Neolithic is marked by the presence of Starčevo culture, Middle Neolithic by the appearance of Korenovo culture in the western part of the interfluve and its cohabitation with the Starčevo culture, and the Late Neolithic by the Sopot culture with two regional types – Ražište and Brezovljani (Dimitrijević 1979; Minichreiter 1992; Težak-Gregl 1993; Marković 1994, etc.). This chronology was based on morphology and decoration of pottery vessels, later with the attempt of absolute dating mainly of archaeological features, without the consideration of the full context. New research, however, challenges both simplistic style approach and absolute dating without proper context (e.g. Botić 2016b; 2017a; 2019; 2020b; 2020c).

2007; Dizdar, Tonc 2016) and possibly in the western area around Bjelovar (Korenovo culture – Težak-Gregl 1993; for radiocarbon dates see Jakucs 2020),[14] somewhat later in the Sava River valley (Miklik-Lozuk 2005; 2006) and the eastern Slavonia (Krznarić Škrivanko 2020). This change is properly archaeologically documented only on a handful of sites with complete data processing still waiting to be performed.

In the Drava River valley, the first site is Virovitica – Brekinja near Virovitica, interpreted by the excavators as an Early Neolithic Starčevo site (Sekelj Ivančan, Balen 2006a; 2006b; 2007) but later long pits of timber framed longhouses of the LBK type were recognized (Botić 2017a: 71, Figs 46–47; 2019: 91, Fig. 2:1; 2020b: 204, Fig. 5). This situation is very similar to the one at the Szentgyörgyvölgy-Pityerdomb site in the western Transdanubia and both sites are similarly dated around 5400 BC (Bánffy 2004; Oross, Bánffy 2009; Bánffy, Oross 2010; Botić 2019; 2020b). This site is situated 11 km south of the Drava River, on a waterlogged and poorly drained pseudogley soil (Botić 2020b: Tab. 1).

Next in the chronological order is Donji Miholjac – Vrancari site near Donji Miholjac. This site exhibits four different pottery styles[15] in the mixed context (Botić 2020b) and remains of timber framed longhouses (Botić 2019; 2020b), situation so unusual in the interfluve that the excavators' first explanation still leans on the old interpretation of pottery styles (Dizdar, Tonc 2016). However, radiocarbon dates indicate much older appearance of Ražište style in this context, i.e. around 5400 BC or slightly later.[16] This site is situated very close to the Drava river, especially the old river bed, and on the poorly drained luvisol on loess (Botić 2020b: Tab. 1). Two other sites with only Ražište style pottery are situated further south (Golinci – Selište, close to the Vrancari site and Podgorač – Ražište, about 30 km south, on the elevated ground).

In the Sava River valley, three sites with timber framed longhouses, but of somewhat different type, are known: Gornja Vrba – Savsko polje (Bodružić 2016), Kruševica – Njivice (Miklik-Lozuk 2005; 2006) and Dubovo – Košno (Marijan 2007). One radiocarbon date from Kruševica – Njivice and six from Dubovo – Košno sites were published but without full context (Miklik-Lozuk 2014; Marijan 2001; 2006; Obelić *et al*. 2002; 2004; 2011). These dates indicate possible later formation of settlements with this kind of architecture in the Sava valley.[17] All three sites are located on the poorly drained soils close to the Sava River or on its left bank (Botić 2020b: Tab. 1).

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14 Radiocarbon dates from the interfluve are not known, the only partially published date comes from the recent rescue excavations at Kukunjevac – Brod site near Lipik, in the westernmost part of Slavonia, and the latest Korenovo phase with red crusted painted motifs: Beta-340932, 4940–4790 calBC 95% (Ivanković 2013: 173; 2014: 58).

15 Late Starčevo, early Vinča, early Ražište and early LBK.

16 Chronological sequence of various pottery styles appearing during the Middle and Late Neolithic in the Sava–Drava–Danube interfluve are still in debate. Certain indications, such as early dates from this site and eponym Podgorač – Ražište site but also from the sites around Pécs in south-eastern Baranya region (e.g. Szederkény-Kukorica-dűlő and Szemely-Irtás – Jakucs 2020) as well as different morphological and decorative characteristics, clearly separate Ražište style from Sopot style which seems to form in a different micro region somewhat later. What is the chronological relationship with Korenovo style (previously established as the local variant of the LBK – see Težak-Gregl 1993) is also not known as the radiocarbon dates for this style from the interfluve are missing. The best chronological sequence for the Middle Neolithic is, however, known from already mentioned south-eastern Baranya region (Jakucs *et al.* 2016; Jakucs 2020).

17 Obelić *et al.* (2004) interpreted these dates as the oldest Sopot phase but it is not clear from which features the samples came from and from which context because Early Neolithic Starčevo style is also reported from this settlement (Marijan 2006; 2007). Very few fragments of pottery were published (Marijan 2006: 49–50) which are interpreted as Sopot finds but may be interpreted in the frame of the later phase of Ražište style as well (e.g. compare fragments 20 and 21 on pp. 50 decorated with the zig-zag motifs with a vessel from Novi Perkovci – Krčavina site in Botić 2020b: Fig. 3). Full post excavation analyses were never done for all three sites.

Moving geographically eastwards to the eastern Slavonia region and in time to the Late Neolithic phase, one encounters multi-layered tell sites such as Vinkovci – Sopot and possibly Bršadin – Pašnjak pod selom (Krznarić Škrivanko 2012; Botić 2020c). Both settlements are located on the bank of a watercourse and on a very low altitude: Sopot at about 82 m a.s.l. near Bosut and Bršadin at about 81 m a.s.l. in the Vuka River bed. Although on different types of soil, both settlements are located in the waterlogged and/or poorly drained environment. Sopot, eponym site for the Late Neolithic Sopot culture in Eastern Slavonia, i.e. eastern Sava–Drava–Danube interfluve (Dimitrijević 1968; 1979), as all of the tell sites found only in this region,[18] has a different type of architecture: houses were built of timber but the floors were made of clay and the dimensions of the houses are much smaller (Krznarić Škrivanko 2015) in comparison to the longhouses of LBK type described above. Radiocarbon dates for this pottery style, available from tells and some flat sites, group after 5000 BC (**Fig. 3**) with some exceptions already mentioned above. Newly published data for Vinkovci – Zablaće site (Krznarić Škrivanko 2020),

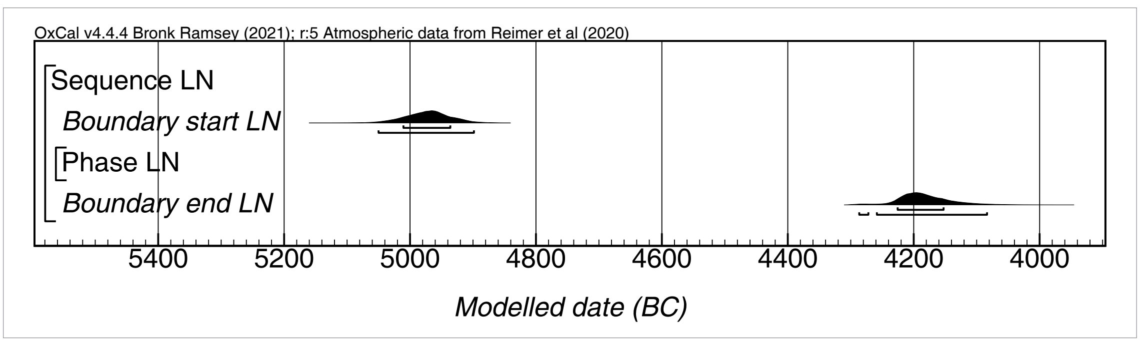

Fig. 3. Start and end sequence of Late Neolithic radiocarbon dates (OxCal v. 4.4.4, ©Bronk Ramsey 2021; made by K. Botić) / *Sl. 3. Početni i završni slijed kasnoneolitičkih radiokarbonskih datuma (OxCal v. 4.4.4, ©Bronk Ramsey 2021; izradila K. Botić)*

situated at the western entrance to the town of Vinkovci, may represent the missing link with the earliest Vinča phases[19] in this region – four radiocarbon dates group after 5300 BC (**Fig. 4**). Moreover, traces of timber framed longhouses were found there, among other features, some of which are of the same type as the one from Gornja Vrba – Savsko polje (Bodružić 2016: 130). Unfortunately, these dates come without full context.

Small scale excavation of Bršadin – Pašnjak pod selom site could not provide full details of the architecture of this Late Neolithic settlement, although timber houses must be expected, but provided very interesting insight into the exact time of foundation of the excavated part of the settlement and valuable data about the treatment of this foundation (Botić 2020c). Situated in the Vuka river bed, very close to the water stream, this site provides possible indirect environmental data about the time it was founded. In 2016 two geological cores were drilled at the site with results pending (Botić 2017a: 38, Figs 17–18; 2017b). Remains of material culture are somewhat different from the Sopot tell site, although late Sopot and late Vinča pottery styles are present. Radiocarbon dates, when compared to the dates and chronological phases from Vinča Belo brdo site (Tasić *et al.* 2016a; 2016b), confirm firmer link with the Vinča finds (Botić 2020c).

18 Tell sites are only found in the eastern Slavonia and western Syrmia regions with the exception of Pepelana tell situated a few kilometres south of Virovitica.

19 The end of the Vinča A and the beginning of the Vinča B phase (for detailed discussion about the beginning of Vinča and dating of its phases see e.g. Jakucs *et al.* 2016; Jakucs 2020; Whittle *et al.* 2016; Tasić *et al.* 2016a; 2016b; Borić 2015, etc.).

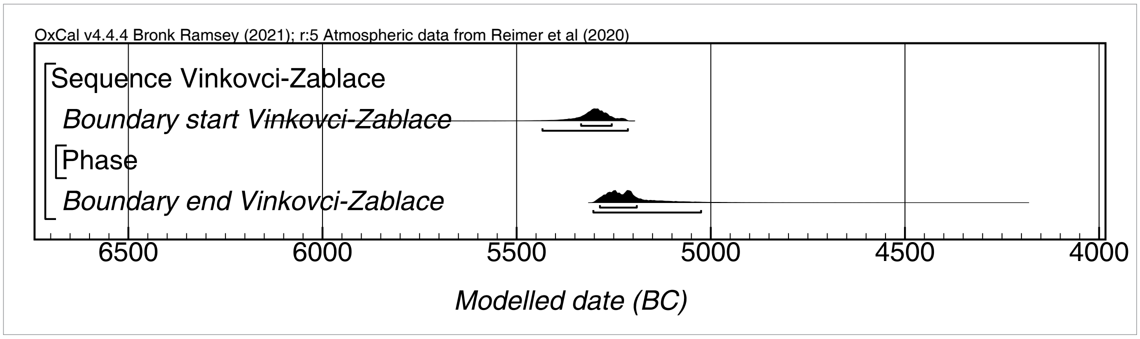

Fig. 4. Start and end sequence of radiocarbon dates for the Vinkovci – Zablaće site (OxCal v. 4.4.4, ©Bronk Ramsey 2021; made by K. Botić) / *Sl. 4. Početni i završni slijed radiokarbonskih datuma za lokalitet Vinkovci – Zablaće (OxCal v. 4.4.4, ©Bronk Ramsey 2021; izradila K. Botić)*

Discussion

Change in global weather patterns we are witnessing today provide us with valuable data on complex interconnections between environment and human occupation. Past extreme weather patterns may have had strong impact on subsistence strategies of the Neolithic populations along their presumed migration routes from the Middle East, through the Balkan Peninsula (see e.g. Budja 2007; Botić 2016a; 2016b; Krauß *et al*. 2018; Weninger *et al*. 2009; 2014, etc.) towards the Carpathian Basin, as well as the migration of the Central European early Neolithic in the opposite direction (e.g. Gronenborn 2012; 2020; Oross *et al*. 2020, etc.).[20] Although probably not the only reason for the migration and social change, environment and consequently climate change could have contributed to the diversification that can be noted in the archaeological record in the Sava–Drava–Danube interfluve.

IRD 5b or 7.1 ka BP RCC event occurred roughly between 5700 and 5000 BC (Gronenborn 2012: Abb. 3). While during its onset Early Neolithic in Central Europe still has not appeared, in the Sava–Drava–Danube interfluve this period is marked by Starčevo population occupation.[21] In this period drop in ^{14}C production, pronounced flooding in the northern Alpine regions and the Mediterranean, draught in the Middle East around the Dead Sea, low flood activity in the southern Alpine region, drop in temperature[22] etc. is recorded on a macro regional scale (Indermühle *et al.* 1999; Mayewski *et al.* 2004: 245–257, Fig. 2; Migowski *et al.* 2006; Gronenborn 2009: 98, Fig. 1; 2012: Abb. 3; Wirth *et al.* 2013: Fig. 6). Retreating of monsoonal rains in the Northern Africa is recorded during the RCC onset period, culminating in rapid desiccation of Sahara after 5300 BC with a short humid interval between 5000 and 4700 BC (Kuper, Kröpelin 2006; Reimer *et al*. 2013: Fig. 2). In Central Europe, the oldest phase of LBK can be dated to around 5500 BC (Gronenborn 2012: Abb. 3) while quite rapid spread of this culture[23] occurred around 5400 BC and reached southern Transdanubia as well as the Sava–Drava interfluve (Bánffy, Oross 2010; Gronenborn 2012; Oross *et al.* 2020; Jakucs *et al.* 2016; Jakucs 2020; Botić 2017a; 2019; 2020b).

20 Recent radiocarbon models and archaeological data place the formative phase of LBK slightly before 5500 BC with its spreading eastwards to Transdanubia slightly after 5400 BC (Oross *et al.* 2020: Fig. 23).

21 Velimirovac – Arenda 1 site, situated in the Drava region south of the Donji Miholjac – Vrancari site, is dated by two radiocarbon dates to this period, i.e. 5700 BC (Botić 2016b: note 13).

22 Including the North Atlantic SST.

23 Here, term ‘culture’ is used because it is not only the pottery style that spreads from its core area but other aspects of everyday life as well, e.g. construction of houses.

Site	Location	Hydrogeological parameters (HC, Aq)	Distance to major rivers (km)	Relative regional chronology (pottery styles)	Absolute age – all available dates	Bibliography
Slavonski Brod – Galovo	S	50–300, 10–20	2.7	Early Neolithic / Late Neolithic (Starčevo / ?)	6000–5150 BC / 6031±24 BP (4996–4847 calBC, 95.4%)	Botić 2016b; 2017a / unpublished
Zadubravlje – Dužine	S	10–50, 10–20	5	Early Neolithic (Starčevo)	6000–5150 BC	Botić 2016b; 2017a
Gornja Vrba – Savsko polje	S	50–300, 10–20	0 (river's bank)	Middle / Late Neolithic (?) (Ražište, classical Sopot?)	?	unpublished
Kruševica – Njivice	S	50–300, 5–10	2	Late Neolithic (LBK?, classical Sopot?)	6115±60 BP (5218–4851 calBC, 95.4%)	Botić 2020b
Dubovo – Košno	S	50–300, 10–20	1.5	? (Early / Middle / Late Neolithic?) (Starčevo, LBK?, classical Sopot?)	5900–4900 BC	Botić 2020b
Velimirovac – Arenda 1	D	10–50, 10–20	29	Early Neolithic (Starčevo)	5800–5550 BC	Botić 2020b
Pepelana	D	-	16.5	Early Neolithic (Starčevo, early LBK/Vinča A?)	-	Minichreiter 1992
Virovitica – Brekinja	D	50–300, 10–20	11	Early / Middle Neolithic (Starčevo, early LBK)	5400 BC	Botić 2019
Donji Miholjac – Vrancari	D	10–50, 10–20	3 (1.5 to old meander)	Middle Neolithic	5400–5350 BC	Botić 2019
Golinci – Selište	D	10–50, 10–20	9.5 (7.5 to old meander)	Middle Neolithic	6160±45 BP (5226–4980 calBC, 95.4%)	Botić 2019
Podgorač – Ražište	D	10–50, 20–30	28	Middle Neolithic	5350–4950 BC	Botić 2019
Novi Perkovci – Krčavina	D-S If	10–50, 20–30	14 (Sava)	Late Neolithic	5000–4600 BC	Botić 2019
Vinkovci – Sopot	D-S-D If	10–50, 30–40	0 (Bosut's bank)	Early Neolithic / Late Neolithic (classical Sopot)	6000 BC	Botić 2016b / Botić 2017a; Krznarić Škrivanko 2015
Vinkovci – Zablaće	D-S-D If	<10, 30–40	3.6 (Bosut)	Middle / Late Neolithic (? / classical Sopot)	5300–5200 BC	Krznarić Škrivanko 2020
Bršadin – Pašnjak pod selom	D-S-D If	<10, 30–40	0 (Vuka river bed)	Late Neolithic (late classical Sopot and Vinča)	4800–4621 BC	Botić 2020c
Gornji Brezovljani	D-S If	-	43 (Drava) 36 (Sava)	Late Neolithic (Brezovljani)	4900–4614 BC	Botić 2020b
Malo Korenovo	D-S If	-	38 (Drava)	Middle / Late Neolithic (Korenovo)	-	
Kukunjevac – Brod	S	-	22 km (Sava)	Middle (?) / Late Neolithic (Korenovo)	4940–4790 calBC (95%)	Ivanković 2014
HUNGARY						
Szentgyörgyvölgy-Pityerdomb	W Tr	-	21.3 (Mura river)	Middle Neolithic (Starčevo, early LBK)	5480–5340 BC	Bánffy 2004; Bánffy, Oross 2010
Sormás-Török-földek	W Tr (Zala C.)	-	12.7 (Mura river)	Middle/Late Neolithic (early LBK, LBK Keszthely, Sopot/ Brezovljani?, Lengyel)	5470–4610 BC	Náfrádi *et al.* 2015
Szederkény-Kukorica-dűlő	SE Tr	-	16 (Danube)	Middle/Late Neolithic (Vinča A, early LBK, Ražište, LBK Biňa-Bicske, LBK Milanovce, Korenovo, LBK Notenkopf/ Želiezovce)	5350–5165 BC	Jakucs *et al.* 2016; Jakucs 2020
Szemely-Irtás	SE Tr	-	26.8 (Danube)	Middle/Late Neolithic (Ražište, Korenovo, LBK Keszthely/Notenkopf/Želiezovce, 'hybrid', Sopot or Lengyel)	5185–4780 BC	Jakucs 2020
SERBIA						
Vinča – Belo Brdo	N Se	-	0 (Danube's bank)	Late Neolithic	5300–4495 BC	Tasić *et al.* 2016a; 2016b

Table 2. Archaeological sites mentioned in the text. Location of sites in relation to larger rivers: S = Sava River valley, D = Drava River valley, D-S If = Drava–Sava interfluve, D-S-D If = Drava–Sava–Danube interfluve, W Tr = western Transdanubia, SE Tr = southeastern Transdanubia, N Se = northern Serbia. Hydrogeological parameters: HC = hydraulic conductivity (m/day), Aq = aquitard thickness (m) (after: Brkić *et al.* 2020: Figs 2–3) / *Tablica 2. Arheološki lokaliteti spomenuti u tekstu. Smještaj lokaliteta u odnosu na veće rijeke: S = dolina Save, D = dolina Drave, D-S If = međurječje Drave i Save, D-S D If = međurječje Drava–Sava–Dunav, W Tr = zapadna Transdanubija, SE Tr = jugoistočna Transdanubija, N Se = sjeverna Srbija. Hidrogeološki parametri: HC = hidraulička provodljivost (mjesec/dan), Aq = debljina akvitarda (m) (prema Brkić* et al. *2020: sl. 2–3)*

On the micro regional scale, in the westernmost part of the Sava–Drava interfluve conditions seem to have been drier and colder during this onset period changing rapidly to wetter and warmer conditions around 5400 BC or slightly after, as indicated by the change in speleothem $\delta^{13}C$ values in the Nova Grgosova cave (Surić *et al.* 2021: Fig. 6); further increase in temperature and humidity continued in the 5th millennium, reaching a peak around 4500 BC. In the middle and lower Tisza region in the Pannonian Plain, settled by the Early Neolithic Körös population, conditions changed by the 5690 BC: increased rainfall triggered substantial flooding, although warmer conditions prevailed (Gulyás *et al.* 2020). At the turn of the 6th to the 5th millennium BC (at the end of the 7.1 ka BP event), this region underwent change in settlement organization, from flat to multi-layered (tells), which occurred during relatively stable hydrological and favourable warm climatic conditions (Gulyás, Sümegi 2011). Next phases of occupation of this region saw change in environmental conditions in which flooding returned; by 4500 BC this area was once again transformed by abandonment of tell sites (Gulyás, Sümegi 2011).

Change in material culture in the Sava–Drava interfluve occurred around 5400 BC, as stated before, during the period following rapid change in environmental conditions as documented in Nova Grgosova cave. Settlements founded at that time south of the Drava River were situated on poorly drained soils in the alluvial aquifer with low to medium hydraulic conductivity and with aquitard[24] thickness of 10–20 m (Brkić *et al.* 2010: Figs 2–3). Sava region further south might have been settled in the middle Neolithic by the same population slightly later. Settlements there were formed on similar type of soil in the alluvial aquifer with medium hydraulic conductivity and the same aquitard thickness of 10–20 m (Brkić *et al.* 2010: Figs 2–3). Vinkovci – Zablaće site, dated to the period after 5300 BC (Krznarić Škrivanko 2020) is situated on low hydraulic conductivity aquifer with aquitard thickness of 20–30 m (Brkić *et al.* 2010: Figs 2–3). Several questions arise: was this type of environment sought after by the Middle Neolithic population, was the construction of timber framed longhouses necessary for the same environment and can we trace two phases of Middle Neolithic settlement, i.e. the first around 5400 BC and the second after 5300 BC?

Gradual increase of warmer and wetter conditions possibly reached optimum by the 5000 BC, a period at the end of the 7.1 ka BP event when formation of tell sites is documented both in the easternmost part of the Sava–Drava–Danube interfluve and in the central Pannonian Plain (Surić 2021: Fig. 6; Gulyás, Sümegi 2011; Krznarić Škrivanko 2012; 2015; Botić 2017a; 2020c). Region of tell formation in the interfluve is the same where Zablaće site is situated, on low hydraulic conductivity aquifer with the varying aquitard thickness between 20–30 and 30–40 m (Brkić *et al.* 2010: Figs 2–3). However, most of the tell settlements were initially placed on very edges of watercourses or in river beds as shown on the two examples (Vinkovci – Sopot and Bršadin – Pašnjak pod selom). Time of their abandonment at the end of the Neolithic and beginning of the Eneolithic (local chronology) is not very clear. Sopot tell was abandoned very late, at the turn of the 5th to the 4th millennium BC (Fig. 4) while radiocarbon dates for other such sites are not available or are conventional dates rather than AMS.[25] Again, question is whether abandonment of such settlements occurred because of increase in humidity by the end of the 5th millennium BC. Bakrač *et al.* (2015) concluded that the percentage of *Tilletia* (mildew) spores reached more than 60% of the sample in the youngest phase of the Sopot tell occupation (4340–3940 BC) which might indicate too wet conditions for wheat growth.

24 In northern Croatia they consist mostly of semi-permeable silty-clayey deposits (Brkić *et al.* 2010: 284).

25 For the list of Late Neolithic radiocarbon dates see Botić 2017a: 223, Tab. 2.

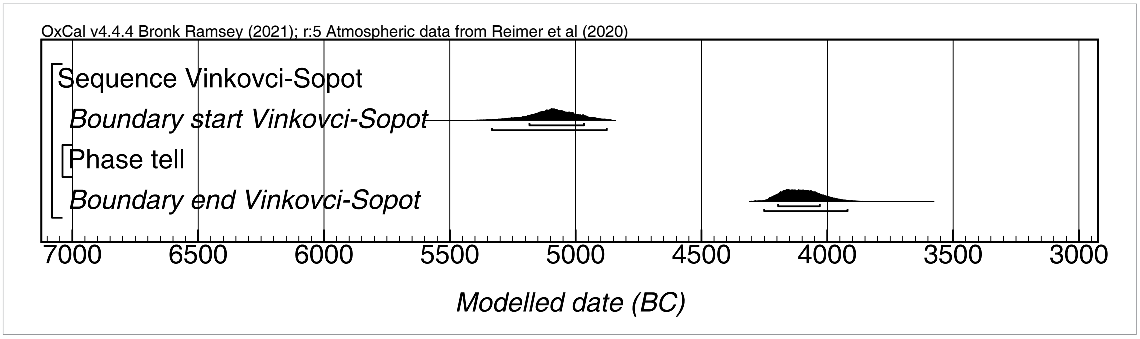

Fig. 5. Start and end sequence of radiocarbon dates for the Vinkovci – Sopot site (OxCal v. 4.4.4, ©Bronk Ramsey 2021; made by K. Botić) / *Sl. 5. Početni i završni slijed radiokarbonskih datuma za lokalitet Vinkovci – Sopot (OxCal v. 4.4.4, ©Bronk Ramsey 2021; izradila K. Botić)*

Concluding remarks

In this short overview some preliminary observations were made regarding possible interconnection between environmental changes during the 7.1 ka BP RCC event and changes present in the archaeological records in the relatively small Sava–Drava–Danube interfluve region. Further extensive study of the archaeological record is needed, as well as new geoarchaeological datasets that would provide much needed environmental data comparable to already published datasets in the wider region, in order to answer questions raised here. The full potential of the archaeological record in overall environmental data is still not sufficiently appreciated in both archaeological and environmental studies. We hope that future research will provide a better interdisciplinary approach to this problem.

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SAŽETAK

Dvije strane 7.1 ka BP RCC događaja u južnom dijelu Karpatske kotline: ljudska prilagodba promjenama okolišnih uvjeta tijekom srednjega i kasnog neolitika

Odnos zajednica u prošlosti i njihovog neposrednog okoliša u hrvatskoj se arheologiji vrlo rijetko obrađuje. Također je vrlo malo paleookolišnih podataka objavljeno za prostor međurječja Save, Drave i Dunava (samo dvije: Bakrač *et al.* 2015 i Hruševar *et al.* 2020). Ovaj rad pokušaj je povezivanja pojedinih promjena u ostacima materijalne kulture iz arheoloških slojeva datiranih u srednji i početak kasnoga neolitika u kontinentalnoj Hrvatskoj, tj. prostoru međurječja Sava–Drava–Dunav s globalnim ili regionalnim klimatskim/okolišnim podacima. Već je prije ustanovljena veza između pojave i razvoja neolitičkih zajednica te njihove transformacije na početku eneolitika s globalnim klimatskim događajima, a pojedini arheološki podaci možda potvrđuju pretpostavku o sličnoj povezanosti u vrijeme srednjega i početka kasnoga neolitika (prema lokalnoj kronologiji) na istom prostoru (**Sl. 1**).

Definicije RCC i IRD događaja

Događaji brze klimatske promjene (*Rapid Climate Change (RCC) event*) definirani su kao ponavljajuće globalne anomalije zahlađenja koje se pojavljuju otprilike svakih 1.450 godina. Za holocen je definirano šest RCC događaja: 9000–8000, 6000–5000, 4200–3800, 3500–2500, 1200–1000 i 600–150 calBP (BP = *before present* (prije sadašnjosti), tj. prije 1950.). Ova su razdoblja karakterizirana slabijom sunčanom aktivnošću te najviše izmjenom Sibirske i Azorske anticiklone s Islandskom ciklonom tijekom kojih se stvaraju uvjeti koji podržavaju dotok ekstremno hladnog polarnog zraka u Europu.

Događaji naglog otapanja leda (*Ice rafted debris/detritus (IRD) event*) ili Bond događaji opisani su kao epizode zahlađenja potaknute promjenama u slanosti sjevernog Atlantika izazvanima otapanjem sjevernoameričkog ledenjaka, prilikom čega velike količine slatke vode i sedimenata naglo utječu u more. Time se mijenja cirkulacija tople struje sjevernog Atlantika, a onda i vremenski obrasci. Na ove događaje može dijelom utjecati i promjena u insolaciji, tj. u fazama visoke i niske solarne aktivnosti. Na insolaciju može utjecati i pojačana vulkanska aktivnost, posebno erupcije višega indeksa eksplozivnosti (VEI) (**Tab. 1**). U razdoblju važnom za ovaj rad (5990.–5000. pr. Kr.) zabilježene su jedna erupcija VEI 7 i dvije erupcije VEI 6 (za usporedbu, erupcija vulkana Cumbre Vieja na otoku La Palma (Kanarski otoci), trenutno u tijeku, klasificirana je kao VEI 2) (**Sl. 2**).

7.1 ka BP događaj i arheološki podaci (Sl. 2)

Globalni i makroregionalni podaci o okolišu

Pojedine nove studije o povezanosti okoliša i arheoloških podataka koncentrirane su na RCC ili na IRD događaje. Gronenborn (npr. Gronenborn 2007; 2010; 2012 itd.) datira IRD 5b fazu u 5700.–5100. pr. Kr. i uz početak kulture linearnotrakaste keramike (LTK) u srednjoj Europi oko 5500. pr. Kr. Nešto prije samoga početka kulture LTK pojavljuju se naglašena plavnost na prostoru sjeverno od Alpa, pad temperature, naglašenija Sibirska anticiklona i slabija Islandska ciklona itd. U područjima južno od Alpa te u istočnoj Europi i na Mediteranu zabilježene su slabija plavna aktivnost i suša na Bliskom istoku, a u sjevernoj Africi nešto prije 5300. pr. Kr. započinje sušenje egipatske Sahare (**Sl. 2**). Istovremeno, Weninger *et al.* (2009; 2014 itd.) ne prepoznaju jači RCC događaj u vrijeme IRD 5b, no u ovome radu promatramo promjene u okolišu (5500.–5100. pr. Kr.) kao RCC događaj.

Mikroregionalni podaci o okolišu

Na regionalnoj razini objavljeno je nekoliko grupa podataka o okolišu: palinološka studija za Prokoško jezero u središnjoj Bosni (Dörfler 2013), antrakološka i palinološka studija uzoraka kasnoneolitičkog lokaliteta Sormás-Török-földek te podaci iz geološke bušotine kraj Zalavara (oba u Zala okrugu, jugozapadna Mađarska; Náfrádi *et al.* 2015),

no ovi podaci nisu usporedivi s prostorom međurječja. Podaci iz pećine Nova Grgosova kod Samobora bilježe naglu promjenu okolišnih uvjeta nakon 5400. pr. Kr. (Surić *et al.* 2021), ali se ni ovi podaci ne mogu koristiti za istočni dio međurječja, radi različite godišnje količine oborina. Jedina preliminarna palinološka studija za istočnu Slavoniju temelji se na uzorcima iz kasnoneolitičkog tel naselja Sopot, ali bez značajnijih podataka o promjenama u okolišu osim antropogenog (Bakrač *et al.* 2015).

Arheološki zapis i indirektni podaci o okolišu (**Tab. 2**)

Promjene u arheološkim zapisima pojavljuju se oko 5400. pr. Kr., prvo u Podravini te možda oko Bjelovara i nešto kasnije u Posavini i istočnoj Slavoniji. Ova je promjena, međutim, arheološki dokumentirana na samo nekoliko lokaliteta koji čekaju detaljniju obradu i objavu. U Podravini to su Virovitica – Brekinja i Donji Miholjac – Vrancari na kojima se prvi puta bilježi pojava dugih kuća rane LTK uz pojavu različitih keramičkih stilova u istom kontekstu (na lokalitetu Vrancari: kasnostarčevački, ranovinčanski, rano Ražište i rana LTK), situacija slična onoj na lokalitetima Szentgyörgyvölgy-Pityerdomb, Szederkény-Kukorica-dűlő i Szemely-Irtás. U ovom kontekstu, kao i na eponimnom lokalitetu Ražište kod Podgorača, nalazi sopotske kulture tzv. Ražište tipa datirani su ranije od same klasične sopotske kulture u istočnoj Slavoniji, što ih jasno odvaja, vremenski i tipološki, od ove posljednje. U lokalitete s nalazima Ražište stila u Podravini treba ubrojiti i lokalitet Golinci – Selište. Svi lokaliteti nalaze se u nizini osim lokaliteta Ražište. U Posavini se nalaze tri lokaliteta sa sličnim tipom arhitekture: Gornja Vrba – Savsko polje, Kruševica – Njivice i Dubovo – Košno, datirani nešto kasnije od onih u Posavini. Svi se nalaze u riječnoj dolini. U istočnoj Slavoniji rasprostiru se kasnoneolitička tel naselja, npr. Sopot i možda Bršadin – pašnjak pod selom. Oba su smještena na samim obalama rijeka, a datirana su nakon 5000. pr. Kr. (**Sl. 3; 5**). Kuće su drugačijeg tipa i veličine od onih u Podravini i Posavini. Novoistraženi lokalitet Vinkovci – Zablaće, jednoslojno naselje s dijelom arhitekture sličnom onoj LTK kruga, djelomično je datiran oko 5300. pr. Kr. (**Sl. 4**) i možda predstavlja poveznicu s najranijim vinčanskim fazama u ovom prostoru.

Klimatske promjene, iako možda ne jedini razlog migracija i društvenih promjena, mogle su pridonijeti promjenama koje se pojavljuju tijekom srednjega neolitika u međurječju Save, Drave i Dunava. Klimatski događaj IRD 5b / 7.1 ka BP RCC (5700.–5000. pr. Kr.) zahvatio je ovo područje u vrijeme ranoneolitičke starčevačke kulture, a tek se nakon 5500. pr. Kr. pojavljuje ranoneolitička kultura LTK u srednjoj Europi. Oko 5400. pr. Kr. kultura LTK širi se iz svog matičnog prostora u južnu Transdanubiju i u prostor međurječja Save i Drave. U početku ovog klimatskog događaja pojavljuju se znatno vlažniji uvjeti sjeverno od Alpa, dok u južnoj Europi, na Bliskom istoku i u sjevernoj Africi vladaju sušniji uvjeti, a temperatura pada. Podaci iz pećine Nova Grgosova bilježe sušnije i hladnije uvjete koji se naglo mijenjaju oko 5400. pr. Kr. u vlažnije i toplije, dosežući vrhunac oko 4500. pr. Kr. U istočnoj Slavoniji uvjeti su od 5000. pr. Kr. (po završetku klimatskog događaja) vjerojatno bili znatno suši, jer se barem dio naselja osniva u nizinama uz same vodotokove, a najvjerojatnije su napuštena oko 4500. pr. Kr. ili nešto kasnije, u vrijeme povratka znatno vlažnijih uvjeta.